REMARKS

Claims 1, 2, 6 to 10, and 12 to 24, as amended, appear in this application for the Examiner's review and consideration. Claims 13 to 16 have been withdrawn, as being directed to a non-elected invention. Claims 3 to 5 and 11 were canceled by a prior Amendment. The amendments are fully supported by the specification and claims as originally filed. Therefore, there is no issue of new matter.

Claim 24 stands rejected under 35 U.S.C. § 112, second paragraph, as allegedly being indefinite for the reasons set forth on page 2 of the Final Office Action. The Final Office Action sates "it is not clear whether the precursor liquid should be *only* in the center of the arrangement or in the center as well."

In response, Applicant submits that claim 24 depends from claim 17, and has been amended to recite "wherein the infiltrating of the arrangement with the precursor liquid comprises incorporation of the precursor liquid into a center of the arrangement," thereby clarifying the scope of the infiltration. Therefore, the claims particularly point out and distinctly claim the subject matter Applicant regards as the invention. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claim 24 under 35 U.S.C. § 112, second paragraph.

Claims 1, 2, 4, 6 to 9, 11, and 12 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over U.S. Patent No. 3,164,487 to Carley-Macauly et al. (Carley-Macauly) in view of U.S. Patent No. 3,305,325 to Nicholson et al. (Nicholson) and U.S. Patent No. 4,073,834 to Mysels, and further in view of U.S. Patent No. 3,129,141 to Burnham et al. (Burnham) and U.S. Patent No. 6,190,162 to Smith et al. (Smith) for the reasons set forth on pages 3 to 6 of the Final Office Action. In the rejection, the Final Office Action states that the reasons for the rejection are those set forth in the Office Action dated October 2, 2008.

With regard to Carley-Macauly, the Office Action, dated October 2, 2008, at page 3, as cited by the present Final Office Action, states:

> Carley-Macauly et al discloses a method of producing carbon-impregnated nuclear fuel element with very low permeability to gases (See column 1, lines 11-16) comprising impregnating a porous artifact having high open porosity and low thermal conductivity (See column 1, lines 20-21) such as nuclear fuel material (See column 3, lines 5-10), e.g. uranium dioxide (claimed porous uranium dioxide arrangement) (See column 1, lines 62, 66-67) or a

> porous silicon carbide (See column 3 , lines 33-34) or porous silica or alumina (See column 2, lines 33-34) by pyrolysis of methane and other hydrocarbons (See column 4, lines 21-45).
>
> Carley-Macauly et al fails to teach that carbon is impregnated by infiltrating a liquid carbon precursor.

In addition, at page 7, the Office Action cited by the present Final Office Action states that Carley-Macauly teaches carbon impregnated artifacts that are produced by placing an artifact, having high open porosity and low thermal conductivity, in an atmosphere of hydrocarbon gas, such that the process increases the thermal conductivity of the artifact impregnated with a hydrocarbon before converting the hydrocarbon to carbon.

With regard to Nicholson, that earlier Office Action states that Nicholson discloses that carbon can be deposited in the pores of substantially any refractory body having intercommunicating network by any available technique, such as pyrolysis of methane and other hydrocarbons, and impregnation of the porous body with phenol-formaldehyde based resinous solution or furfural or the like, followed by carbonization by acidification. However, as stated in that Office Action, Carley-Macauly in view of Nicholson fails to teach that the impregnated liquid carbon precursor is converted to carbon by curing and firing the arrangement.

With regard to Mysels, that Office Action states that Mysels discloses that carbon can be deposited in the pores of a fuel arrangement by use of an impregnant, such as phenol-formaldehyde prepolymer or furfuryl alcohol monomer/prepolymer by first curing the prepolymer, and decomposing the cured polymer. However, that Office Action states that the cited prior art fails to teach that, where silicon carbide is used instead of carbon, the fired arrangement has a higher thermal conductivity than the arrangement without infiltration of the uranium dioxide with the precursor liquid.

With regard to Burnham, that Office Action states that Burnham teaches that ideal characteristics sought in a nuclear reactor fuel element include good thermal conductivity, high heat resistance and heat shock resistance, corrosion resistance, high mechanical strength even at elevated temperatures, and comprises a dense body comprising uranium carbide, graphite, and/or silicon carbide, and, thus, discloses that silicon carbide is suitable for making a dense body of a nuclear reactor fuel element.

With regard to Smith, that Office Action states that Smith discloses that silicon carbide may be deposited on a substrate by applying the liquid pre-ceramic polymer

allylhydridopolycarbosilane to the substrate, curing the polymer, and then pyrolyzing the silicon carbide pre-ceramic polymer mixture.

In response, Applicant submits that the present claims are directed to a method to produce uranium dioxide fuel in pellet shape for use in a light water reactor. The presently claimed method comprises providing an arrangement, where the arrangement comprises porous uranium dioxide. The arrangement is infiltrated with a precursor liquid, where the precursor liquid comprises silicon. The infiltrated arrangement is thermally treated, such that the precursor liquid is converted to a second phase. The step of thermally treating the arrangement comprises curing the infiltrated arrangement, converting the precursor liquid into a solid polymer, and thermally firing the cured infiltrated arrangement, thereby forming nuclear fuel, the nuclear fuel comprising an arrangement having a porous matrix of uranium dioxide, defining pores, and silicon carbide interspersed in the pores of the matrix of uranium dioxide.

Thus, to be within the scope of the presently claimed method, the prior art must disclose or provide a reason for one of ordinary skill in the art to use a method of producing uranium dioxide fuel in which an arrangement comprising porous uranium dioxide is infiltrated with a precursor liquid, comprising silicon, such as a silicon containing polymer, and the infiltrated arrangement is thermally treated, thereby forming nuclear fuel, the nuclear fuel comprising an arrangement having a porous matrix of uranium dioxide, defining pores, and silicon carbide interspersed in the pores of the matrix of uranium dioxide. As discussed below, the cited prior art does not disclose or suggest the presently claimed method or the product of the presently claimed method, and provides no reason for one of ordinary skill in the art to obtain the presently claimed method or the product of the presently claimed method.

Applicant respectfully submits that the Office Action takes the position that, as Carley-Macauly discloses a process for depositing carbon by the pyrolysis of hydrocarbons in a porous artifact, Nicholson discloses that carbon can be deposited in the pores of a porous refractory body by any available technique, Mysels discloses that carbon can be deposited in the pores of a fuel arrangement by use of an impregnant by first curing the impregnant, and then decomposing the cured impregnant, Burnham discloses a fuel element containing silicon carbide, and Smith discloses that silicon carbide may be deposited on a substrate by applying the liquid pre-ceramic polymer allylhydridopolycarbosilane to the substrate, curing the polymer, and then pyrolyzing the silicon carbide pre-ceramic polymer mixture, it would have been obvious to one of

ordinary skill in the art to modify the process disclosed by Carley-Macauly to deposit silicon carbide in a matrix of uranium oxide.

However, the Office Action, the cited references, and the prior art in general fail to provide any guidance as to how a process for impregnating a porous artifact with carbon by the pyrolysis of methane and other hydrocarbons can be modified to impregnate the artifact with silicon carbide. Without such guidance, the process disclosed by Carley-Macauly cannot be modified by one of ordinary skill in the art to obtain the presently claimed invention without undue experimentation. That is, the prior art fails to provide any guidance for depositing silicon carbide in the pores of a porous artifact or for modifying a hydrocarbon pyrolysis process for the deposition of silicon carbide in such pores. As a result, one of ordinary skill in the art could not obtain the presently claimed invention without undue experimentation.

It is well settled law that, although published subject matter is prior art for all that it discloses, the prior art must enable a person of ordinary skill to make and use an invention in order to render the invention unpatentable for obviousness. *See, e.g., In re Kumar*, 418 F.3d 1361, 1368 (Fed. Cir. 2005). The cited prior art clearly fails to provide the guidance that would enable one of ordinary skill in the art to modify the hydrocarbon pyrolysis method of Carley-Macauly to obtain the presently claimed invention. The proposed modification of the disclosure of Carley-Macauly would require undue experimentation, and, thus, the present claims are not obvious.

Should the Examiner not agree with the Applicants' position, the Applicants respectfully request that the Examiner provide some teaching from the prior art that would enable one of ordinary skill in the art to modify the pyrolysis deposition method disclosed by Carley-Macauly to deposit silicon carbide without undue experimentation. Without such a teaching in the prior art, the cited references fail to provide the enabling disclosure required to render the present claims obvious.

In contrast to the presently claimed invention, Carley-Macauly discloses a method for producing carbon-impregnated artifacts. Carley-Macauly, column 1, lines 11 and 12. The disclosed carbon-impregnated artifacts have a low permeability to gases, and may contain fissile material, such as that used as fuel in a nuclear reactor. Column 1, lines 12 to 19; and column 2, lines 28 to 32.

The porous artifacts impregnated with the method disclosed by Carley-Macauly may be formed from carbon, column 2, lines 27 and 28, admixtures of nuclear material and carbon, column 2, lines 53 to 55, nuclear material almost entirely free of carbon

particles, column 3, lines 5 to 11, and from materials free of carbon and nuclear material, such as silica, column 3, lines 30 to 33. After such a silica artifact is impregnated with carbon, the silica can be converted to silicon carbide, producing an impermeable silicon carbide artifact. Column 3, lines 33 to 35. Such an impermeable silicon carbide artifact is not the presently claimed porous uranium oxide matrix, having silicon carbide interspersed in the pores of the matrix. Carley-Macauly does not disclose or suggest that any of the other porous artifacts contain or are converted to silicon carbide.

Carley-Macauly discloses the preparation of carbon-impregnated artifacts only in a process in which the carbon is formed by the pyrolysis of hydrocarbons. As stated above, the disclosure of the hydrocarbon pyrolysis method provides no guidance as to how one of ordinary skill in the art would obtain the presently claimed invention. Carley-Macauly, whether taken alone or in combination with the prior art, fails to provide a disclosure that would enable one of ordinary skill in the art to modify the disclosed hydrocarbon pyrolysis method to deposit silicon carbide in the pores of a porous matrix of uranium dioxide without undue experimentation.

Nicholson does nothing to overcome the deficiencies of Carley-Macauly. At column 5, lines 63 to 70, and column 6, lines 10 to 16 and 20 to 22, Nicholson discloses depositing carbon in the pores of a refractory body, and converting the carbon to silicon carbide by releasing free silicon to react with the carbon. Even if combined with the disclosure of Carley-Macauly, the disclosure of Nicholson will not provide the presently claimed method. Based on the disclosures of Carley-Macauly and Nicholson, one of ordinary skill in the art would not be able to obtain the presently claimed method without undue experimentation. Those references fail to provide any guidance as to how to obtain the presently claimed method and the product of that method.

Mysels does nothing to overcome the deficiencies of Carley-Macauly and Nicholson. Mysels discloses that carbon can be deposited in the pores of a fuel element by placing a phenol-formaldehyde prepolymer or furfuryl alcohol monomer/prepolymer into the pores of the fuel element, curing the prepolymer, and then decomposing the cured polymer. Mysels, whether taken alone or in combination with Carley-Macauly and Nicholson, does not provide any guidance as to how to obtain the presently claimed method and the product of that method. Based on the disclosures of Carley-Macauly, Nicholson, and Mysels, one of ordinary skill in the art would not be able to obtain the presently claimed method without undue experimentation.

Burnham does nothing to overcome the deficiencies of Carley-Macauly and the other cited references. Burnham discloses a fuel element, a fuel element material for nuclear reactors, and a process for making such fuel elements. Burnham, column 1, lines 11 to 13. As disclosed by Burnham, ideal characteristics in a nuclear reactor fuel element include good thermal conductivity, high heat resistance and heat shock resistance, corrosion resistance, high mechanical strength, even at elevated temperatures, good dimensional stability, high fission product retention, high density of fissionable material, and easy formability. Column 1, lines 14 to 20.

The fuel element disclosed by Burnham contains silicon bonded silicon carbide as a base material into which a desired amount of fissionable material is incorporated. Column 1, lines 25 to 29. The disclosed fuel element "comprises a dense body consisting essentially of uranium carbide, graphite, silicon carbide and silicon." Column 1, lines 33 to 35. The uranium carbide is supported by a matrix of silicon bonded silicon carbide, where the uranium carbide is dispersed substantially uniformly throughout the silicon bonded silicon carbide matrix. Column 1, lines 38 to 47. Thus, Burnham discloses nuclear fuel material interspersed into a silicon/silicon carbide matrix, not silicon carbide interspersed in the pores of a uranium oxide matrix, as presently claimed.

Burnham discloses that the fuel element is prepared as follows:

> A quantity of graphite bonded uranium carbide, preferably containing about 30% or more by weight uranium and the remainder carbon, is pulverized to a grain size of from 40 mesh to 200 mesh. The resulting granular product is then mixed, either alone or preferably in combination with a quantity of silicon carbide grain, with a phenol formaldehyde or other suitable resin binder. This mixture is then cold or hot pressed to the desired shape and heated in a suitable atmosphere to cure the resin and drive off the volatiles. Where heat pressing is used, from 3,000 to 10,000 p.s.i. pressure is satisfactory; for cold pressing, 30,000 to 60,000 p.s.i. pressure is desirable. The resulting pressed and cured briquette is then immersed for a short period into molten silicon at from about 3200° F. to 3600° F, during which immersion the resin carbonizes and reacts with the molten silicon to form silicon carbide. Column 1, lines 51 to 67.

As discussed above, and as disclosed by Burnham, the resulting product is a dense body consisting essentially of uranium carbide, graphite, silicon carbide, and silicon, where the uranium carbide is supported by a matrix of silicon bonded silicon carbide. Column 1, lines 33 to 47. That is not the product of the presently claimed invention. Moreover, carbon is required to convert molten silicon into silicon carbide. Immersing

porous uranium oxide in molten silicon will not convert the silicon into silicon carbide. Thus, Burnham provides no guidance that would enable one of ordinary skill in the art to modify the hydrocarbon pyrolysis process disclosed by Carley-Macauly to deposit silicon carbide in a porous artifact

Smith does nothing to overcome the deficiencies of Carley-Macauly and the other cited references. Smith discloses an infrared heater, and methods of making the heater. The heater contains a gas fired burner, having a metallic burner body with a combustion plenum chamber, a matrix which covers the combustion mixture plenum, and a screen made of fibers treated with a silicon carbide forming mixture. The matrix is made from ceramic or metallic fibers treated with a pre-ceramic polymer containing silicon and carbon. As stated in the Office Action, the pre-ceramic polymer may be AHPCS (allylhydridopolycarbosilane).

Smith discloses that AHPCS is a liquid base pre-ceramic polymer. Column 3, lines 30 and 31. Smith discloses that a screen is treated with a silicon carbide forming mixture, such as the liquid base pre-ceramic polymer AHPCS, which is then pyrolyzed. Smith does not disclose or suggest that the AHPCS is first cured to form a solid polymer, and then thermally fired, as presently claimed. Even if one of ordinary skill in the art combined the disclosure of Smith with that of Carley-Macauly and the other cited references, the resulting combination would not provide the presently claimed method or the product of that method. One of ordinary skill in the art, following the disclosure of Smith, whether taken alone or in combination with Carley-Macauly and the other cited reference, would require undue experimentation to obtain the presently claimed method and the product of that method.

As discussed above, neither Carley-Macauly nor the other cited references, whether taken alone or in combination, provide any guidance that would enable one of ordinary skill in the art to modify the hydrocarbon pyrolysis process disclosed by Carley-Macauly to impregnate a porous artifact with silicon carbide with the presently claimed method, thereby obtaining the product of the presently claimed method, without undue experimentation. Thus, the cited prior art references fail to provide an enabling disclosure for one of ordinary skill in the art to obtain the presently claimed invention. Therefore, the present claims are not obvious over Carley-Macauly and Burnham, whether taken alone or in combination. Accordingly, it is respectfully requested that the Examiner withdraw the rejection of claims 1, 2, 4, 6 to 9, 11, and 12 under 35 U.S.C. § 103(a) over the cited references.

Applicants thus submit that the entire application is now in condition for allowance, an early notice of which would be appreciated. Should the Examiner not agree with Applicants' position, a personal or telephonic interview is respectfully requested to discuss any remaining issues prior to the issuance of a further Office Action, and to expedite the allowance of the application.

No fee is believed to be due for the filing of this Amendment. Should any fees be due, however, please charge such fees to Deposit Account No. 11-0600.

Respectfully submitted,

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